Langley Research Center

LPR 1710.42D

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SAFETY PROGRAM FOR THE RECERTIFICATION AND MAINTENANCE OF GROUND-BASED PRESSURE VESSELS AND PIPING SYSTEMS

National Aeronautics and Space Administration

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Responsible Office: Safety and Mission Assurance Office

PREFACE

P.1 PURPOSE

This Langley Procedural Requirement (LPR), in conjunction with LPR 1710.40, implements the requirements of NASA STD 8719.17 “NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PVS)” and is part of the Langley Management System.

P.2 APPLICABILITY

This LPR is applicable to all pressure systems owned by or used at LaRC, including new, existing, temporary, and permanent systems (Government or contractor-owned.) However, systems excluded by LPR 1710.40, “Langley Research Center Pressure Systems Handbook,” are also excluded from the requirements in this LPR.

P.3 AUTHORITY

NPD 8710.5, “NASA Safety Policy for Pressure Vessels and Pressurized Systems.”

P.4 APPLICABLE DOCUMENTS AND FORMS

a. LPR 1710.40, “Langley Research Center Pressure Systems Handbook”
b. LPR 1740.4, “Facility System Safety Analysis and Configuration Management”
c. LMS-TD-5569, “Performing Visual Inspections.”
d. LF 498, “Safety Permit”

P.5 MEASUREMENT/VERIFICATION

None

P.6 CANCELLATION

LPR 1710.42, “Safety Program for Maintenance of Ground Based Pressure Vessels and Pressurized Systems,” dated March 23, 2007.

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CHAPTER 1

1.0 RESPONSIBILITIES

The functions and responsibilities listed below are essential for the management and implementation of this safety program, and supplement the responsibilities listed in LPR 1710.40, “Langley Research Center Pressure Systems Handbook:”

1.1 Pressure Systems Manager (PSM)

1.1.1 The PSM shall be responsible for:

a. Ensuring that LaRC pressure systems meet Agency recertification requirements.
b. Managing and overseeing the implementation of the LaRC Recertification program.
c. Establishing the type of recertification method that is applicable to pressure systems within the scope of this LPR.
d. Determining the final disposition of pressure systems and system components which do not meet Agency recertification requirements.
e. Approving recertification documentation for pressure systems.
f. Issuing a recertification letters for pressure systems.

1.2 Maintenance Manager

1.2.1 In support of the LaRC Recertification program, the LaRC Maintenance Manager shall be responsible for:

a. Establishing a preventive maintenance (PM) program to periodically test pressure relief valves and pressure gages in systems within the scope of LPR 1710.40, “Langley Research Center Pressure Systems Handbook.”
b. Overseeing the performance of maintenance on pressure systems in accordance with maintenance program requirements.
c. Managing the execution of repairs and corrective actions to pressure systems.

1.3 Recertification Group Manager (RGM)

1.3.1 The RGM shall be responsible for:

a. The overall implementation of the ground-based pressure systems recertification program.
b. Maintaining a database of pressure systems within the scope of the LaRC Recertification program.
c. Maintaining pressure system certification/recertification documents as part of a recertification file for each system, e.g., engineering analyses, drawings, sketches, inspection reports, manufacturer’s catalog data, and waivers.

d. Performing structural integrity assessments to provide the PSM with recommendations regarding the disposition of pressure system and pressure system components.
e. Developing weld location drawings, specifications, statements of work, and procurement packages as necessary to implement the corrective actions.
f. Developing in-service inspection plans and documenting the rationale for these inspections.
g. Performing periodic inspections as required by inspection plans and developing in-service inspection reports.
h. Initiating maintenance work requests to resolve inspection findings.
i. Presenting progress reports of the recertification program to the PSM and the LaRC Safety Manager at least quarterly.
j. Maintaining recertification program documentation under configuration control.

1.4 Standard Practice Engineer for Pressure Systems (SPE)

1.4.1 The SPE for Pressure Systems is responsible for:

a. Serving as the Center expert and final authority on the application of national consensus standards and LaRC requirements concerning ground-based pressure systems
b. Ensuring that LaRC pressure systems meet Agency requirements.
c. Reviewing all new designs and all plans for modifications or repairs to LaRC pressure systems.
d. As a member of Operational Readiness Review (ORR) boards, certifying new pressure systems for initial operation.

1.5 Safety and Facility Assurance Branch (SFAB) Safety Engineer

1.5.1 In support of the LaRC Recertification program, the cognizant SFAB Safety Engineer shall be responsible for:

a. Identifying the hazards associated with pressurized systems, assessing their severity and probability of occurrence, and determining any controls necessary to abate them.
b. Developing, updating, and maintaining configuration control of pressure systems Risk Analyses.

CHAPTER 2

2.0 RECERTIFICATION OF GROUND-BASED PRESSURE SYSTEMS

2.1 Recertification Program Structure

2.1.1 The LaRC recertification program shall utilize a phased approach to achieve its goals:

a. Phase 1 – Structural Integrity Assessment

The objective of Phase 1 is to:

1. Assess the structural integrity of the pressure system by collecting or developing documentation relating to the construction of the pressure system, establishing the remaining life of the system, and to developing an in-service inspection plan.
2. Assist in performing the structural integrity assessment, nondestructive examination techniques are used to sample the current condition of the system.
3. The initial sample size typically includes 10% of welded joints and all high stress areas.

b. Phase 2 – Major Repairs

The objective of Phase 2 is to:

1. Develop repair plans, specifications, and statements of work to perform corrective actions that may have been identified during the integrity assessment completed in Phase 1.
2. To establish the extent of repairs and corrective actions required, an in-depth nondestructive examination of the problem areas is conducted, typically including 100% of welded joints and all high stress areas.

c. Phase 3 – In-service Inspection

The objectives of Phase 3 are to:

1. Conduct periodic inspections in accordance with the approved inspection plan.
2. Perform minor repairs or corrective actions to abate any observed degradation.
3. Update the system's Recertification file by incorporating inspection reports
4. Ensure repair work orders are completed.
5. Update the remaining service life of the system.

2.2 Recertification Methods

2.2.1 Pressurized systems at LaRC come in a variety of sizes and complexities. The degree of risk to personnel, facilities, and the NASA mission presented by these systems varies greatly. For this reason, several methods for documenting the recertification of these diverse systems are introduced here.

2.2.2 Full Recertification

2.2.2.1 This method is applicable to most ground based pressure vessels and piping systems that are considered to be a permanent part of the Center's infrastructure.

2.2.2.2 Systems undergoing full recertification are documented with a Pressure Systems Document (PSD), a Process Diagram (PD), an Inspection Plan (IP), a risk analysis, a Recertification File, and a Recertification Letter. Note: These documents are discussed in detail in section 2.5.

2.2.3 Low-risk System Recertification

2.2.3.1 This method is applicable to ground based pressure vessels and piping systems that are specifically exempted from full recertification by the PSM based on their limited risk to personnel and facilities. Examples include, but are not limited to, the following:

a. Code-stamped dewars containing cryogenic liquids of nitrogen, oxygen, helium, or argon, operating at constant internal temperature and constant pressure.
b. Pressure vessels containing inert gases in a system with relief valve setting of 150 Pounds Per Square Inch Gage (psig) or less.
c. Small, cart-mounted, piping systems used to test different research test articles or wind tunnel models.

2.2.3.2 Systems undergoing low-risk system recertification are documented with a drawing or sketch (Process Diagram (PD) or isometric), an IP, a Recertification File, and a Recertification Letter.

2.2.4 Permit Recertification

2.2.4.1 This method is primarily applicable to research laboratories where a compressed gas cylinder (K-bottle) is connected to commercial off the shelf laboratory equipment via a pressure regulator and relief device combination. It may also be used to certify temporary pressure system installations.

2.2.4.2 Systems undergoing permit recertification are documented via a completed and approved LF 498, "Safety Permit," including the pressurized systems portion of the form.

2.2.4.3 If the laboratory or temporary system is expected to operate for longer than 1 year, then an inspection plan is also developed. These documents are maintained in the Recertification file.

2.2.5 Department of Transportation (DOT) Recertification

2.2.5.1 This method is applicable to pressurized forged vessels mounted on

transportable trailers (a.k.a., tube trailers) whether they are used in mobile or stationary applications.

2.2.5.2 Systems undergoing DOT recertification are documented with a copy of the purchase specifications and purchase orders issued to DOT-certified contractors, and a copy of the submittals from the Contractor at the completion of recertification. These documents are maintained in the system's Recertification file.

2.2.6 Boiler Recertification

2.2.6.1 This method is applicable to the steam generating boilers at LaRC.

2.2.6.2 Even though Building 1215 is located within the boundaries of LaRC's exclusive federal jurisdiction zone, the boilers are certified by a boiler inspection Contractor certified by the National Board of Boiler Inspectors (NBBI). A copy of the submittals from the boiler inspector is maintained in the Recertification file.

2.3 Recertification Program Requirements

2.3.1 The PSM shall establish the type of recertification method that is applicable to each system within the scope of the recertification program.

2.3.2 Inspection Personnel Training

2.3.2.1 The RGM shall ensure that personnel conducting nondestructive examinations of LaRC pressure systems are trained via a program meeting the requirements of the American Society for Nondestructive Testing (ASNT) SNT-TC-1A "Personnel Qualification and Certification in Nondestructive Testing" or ASNT CP-189 "ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel."

2.3.3 Prioritization of Work Activities

2.3.3.1 The RGM shall develop a prioritized listing of systems within the scope of the program based on factors such as their energy content, exposure of personnel to the release of energy, importance to the Center's mission, age, and other relevant factors.

2.3.3.2 The prioritized listing shall be used as a guideline and a discriminator in establishing the relative sequence by which systems are inspected and recertified.

2.3.4 New Pressure Systems (Code Compliant)

2.3.4.1 Prior to initial certification by an ORR board, the Project Manager or the cognizant engineer responsible for the installation or the modification of a pressure system shall provide the RGM copies of all available documentation.

2.3.4.2 After receiving the information listed above, the RGM shall scan it for completeness and develop a plan for inclusion of the new system in the recertification program.

2.3.4.3 The RGM shall utilize the applicable documentation procedures in this LPR to complete the recertification process.

2.3.4.4 The RGM shall give priority to the development and establishment of the in-service inspection plan.

NOTE: *Fully documented, code-stamped, pressure components generally do not require in-depth analysis or additional inspection to establish their structural integrity, unless it is suspected that a modification to the component was performed without following NBBI procedures.*

2.3.5 Recertification of Existing Systems

2.3.5.1 The RGM shall conduct a structural integrity assessment of existing systems to determine their compliance with the applicable construction codes and standards in force at the time of construction of the system.

NOTE: *The following list shows documents that may be needed to recertify a pressure system:*
(a) Engineering design calculations
(b) Manufacturing catalog sheets highlighting selected part or model numbers
(c) Manufacturer drawings
(d) Mill reports or other material certification
(e) Certificates of compliance
(f) ASME U-1 or U-2 data reports (for pressure vessels)
(g) Special welding procedures used
(h) Inspection reports
(i) Nondestructive examination reports
(j) Test reports
(k) Verification letter
(l) Shakedown procedures and checklist

Potential sources of this information include the system fabricator's files, component manufacturer files, facility files, contract specifications and drawings, and the LaRC electronic document retrieval systems like the Virtual Library, Configuration Management On-Line (CMOL), and Electronic Drawing File (EDF).

2.3.5.2 The RGM shall verify the pressure and temperature ratings of piping and tubing against the pressure rating tables in LPR 1710.40, "Langley Research Center Pressure Systems Handbook."

2.3.5.3 The RGM shall search manufacturer's technical literature to establish recommended maximum operating pressures and temperatures for pressure system components and to determine if national consensus codes or industry standards were used in their design. The RGM may contact component manufacturers to obtain information about specific component designs.

2.3.5.4 In the absence of manufacturer's technical literature, the RGM shall develop equivalent documentation by conducting engineering analyses of the components using applicable construction code formulas and/or other engineering analysis methods as necessary.

2.3.5.5 The RGM shall conduct an initial visual examination of the entire system to look for signs of cracks, corrosion, wear, leakage, excessive vibration, missing fasteners, broken supports, or other surface defects.

2.3.5.6 The RGM shall develop a means to identify the pressure retaining welds in a pressure system, either by weld map drawings, weld databases, or other.

2.3.5.7 The RGM shall conduct an initial radiographic examination of 10% of all pressure retaining welds and all high stress areas identified of non-code-stamped components.

2.3.5.8 If unacceptable welds are found during the initial radiographic examination, the RGM, with concurrence from the PSM, shall examine up to 100% of all welds.

2.3.5.9 The RGM shall conduct an initial ultrasonic spot wall thickness survey of system components to confirm adequate component strength.

2.3.5.10 From time to time, issues may be encountered while assessing the integrity of system components. Table 2.3-1 lists typical evaluation issues and recommended resolutions. Other resolutions are possible provided they meet the intent of the applicable construction codes and NASA standards.

2.3.5.11 If the integrity assessment indicates that some components are not adequate for their maximum operating pressure or temperature, the RGM shall develop recommendations to achieve compliance by means of component repairs or replacements, or by de-rating the system operating conditions.

2.3.5.12 The RGM shall develop an in-service inspection plan to monitor all expected degradation mechanisms affecting the pressure system.

2.3.5.13 The RGM shall document the rationale used in developing each pressure system inspection plan.

2.3.5.14 The RGM shall maintain configuration control of system documentation.

Table 2.3-1 - Some Typical Integrity Assessment Issues And Possible Resolutions

Issue	Possible Solutions
Material specification is unknown / unavailable	a) A small sample of the component material shall be removed for chemical testing and identification, where feasible b) When obtaining a material sample is not feasible, it shall be assumed that the component is fabricated of the lowest strength material in the same material family (carbon steels, stainless steels, coppers, etc.) that is used in fabricating the same product type (e.g., pipes, forgings, castings, or plates)
Component integrity cannot be reasonably analyzed using code formulas and methods	a) Use other known engineering analysis methods (e.g., closed form equations or finite element analysis) and compare calculated global stresses to code allowable stresses. At the discretion of the PSM, local stresses shall also be evaluated b) The Maximum Allowable Working Pressure (MAWP) of components fabricated in quantity, or of some components with factors of safety in excess of 3 with respect to yield point, may be established by conducting tests per Section UG-101, “Proof Tests to Establish Maximum Allowable Working Pressure,” of Section VIII Division 1, ASME B&PV Code if approved by the PSM.
Component made of a known material that is not Code-approved	Allowable stresses to be used in engineering analyses shall be calculated using the "Basis for Establishing Stress Values" section for the applicable Code. This condition requires a waiver per LPR 1710.40

2.3.6 In-service Inspection Program

2.3.6.1 The primary goal of the in-service inspection program is the verification of the structural integrity of a pressure system as the system ages. Secondary goals include, but are not limited to, the field verification of system documentation and the verification of the certification status of relief devices and pressure gages.

2.3.6.2 The RGM shall perform the periodic inspections required by the IP’s and coordinate with the affected Facility Coordinators to schedule the required inspections.

2.3.6.3 For each system inspection conducted, the RGM shall develop a report providing details of the inspection results.

2.3.6.4 As a minimum, the RGM shall forward the inspection report to the Facility Safety Head (FSH), the Facility Coordinator (FC), and the PSM, with a copy placed in the system's Recertification File.

2.3.6.5 The inspection report shall include all necessary descriptions, redlined sketches, and/or photographs to clearly convey the inspection findings.

2.3.7 Handling of Inspection Findings

2.3.7.1 Emergency repairs – When non-compliant components are identified, the RGM and the PSM shall make an assessment to determine whether or not the non-compliance requires emergency repair action. For example, a finding of cracks or a finding of wall thickness below minimum required by the code qualifies the non-compliance as requiring emergency repair. In these cases, the RGM shall immediately report the emergency condition to the FSH and the FC. The RGM shall then initiate an Emergency Trouble Call to resolve the emergency condition.

2.3.7.2 Routine repairs – When non-compliant components are identified and emergency repairs are not warranted, the PSM shall then decide whether temporary means to ensure system integrity are necessary while repair plans are developed, advocated, and implemented. In the event of a de-rating action, a letter shall be sent by the PSM to the FC and the FSH indicating the new limits of operation for the pressure system.

2.3.7.3 For routine repairs, the RGM shall initiate maintenance work orders attaching any necessary photographs and/or sketches to describe the scope of the required repairs.

2.3.7.4 For repairs with estimated cost exceeding the cost limit of a routine repair, the RGM shall prepare a procurement-ready repair package including any necessary photographs and sketches to describe the scope of the required repairs. The PSM is then responsible for initiating any necessary funding advocacy to accomplish the repairs.

2.3.7.5 When work orders initiated as a result of recertification findings are closed out, the RGM shall conduct a brief inspection of the repaired areas to confirm completion of the work and submit a re-inspection letter to document closure of the findings.

2.3.7.6 Documentation describing repairs completed as a result of recertification activities shall be kept in the system's Recertification file (statements of work, photographs, descriptions, inspection reports, etc.)

2.4 Documentation Requirements

2.4.1 Pressure Systems Documents

2.4.1.1 When required by the method of recertification used, the RGM shall develop a PSD to document pressure system components.

2.4.1.2 The PSD shall include drawings or sketches of piping systems, showing components in the system. These drawing/sketches shall assign a unique number to each pressure retaining component for identification purposes.

2.4.1.3 The PSD shall include a database of component data for piping systems, containing salient information such as pipe sizes, wall schedules, dimensions, flange and valve class ratings, manufacturer's nameplate data, relief valve set points and capacity, the location of welds and support structures, and other information, as applicable to each component.

> ***NOTE:*** *Figures E-2 and E-3 show a typical piping system PSD sketch and a sample component database sheet.*

2.4.1.4 For pressure vessels and pressurized wind tunnel shells, the PSD shall contain a listing of drawings of the pressure shell (e.g., design drawings, fabrication drawings, inspection drawings, and weld maps) and a report identifying the safety devices protecting the vessel.

2.4.2 Recertification Files

2.4.2.1 The Recertification File for each pressure system shall serve as repository for non-configuration controlled documentation used as a basis for recertification.

2.4.2.2 The Recertification File for a pressure system shall have the organization shown in Figure E-1.

2.4.2.3 The contents of a Recertification File shall be customized to meet the needs of the system being documented.

2.4.3 Inspection Plans

2.4.3.1 The purpose of an IP is to ensure that system degradation is properly monitored and to identify the need for corrective actions.

2.4.3.2 Guidelines for the development of inspection plans are listed in Appendix C.

2.4.3.3 Recommendations from the manufacturer of pressure system components and recommendations resulting from failure modes and effects analyses shall also be incorporated into the IP as appropriate.

2.4.4 Process Diagrams

2.4.4.1 A process diagram is used to show the interconnection of equipment in a piping system, such that the flow of the process fluid can be followed.

2.4.4.2 Process diagrams shall accurately represent the sequence of equipment in the piping system and their interconnections within the system and to the outside. Physical details such as piping bends and supports need not be shown.

2.4.4.3 Process diagrams shall identify the set points of safety devices such as relief valves, burst discs, and pressure switches.

2.4.4.4 Process diagrams shall clearly indicate where important process parameters change, such as pressure, temperature, physical state, or composition.

2.4.5 Risk Analyses

2.4.5.1 A Risk Analysis in accordance with LPR 1710.40, “Langley Research Center Pressure Systems Handbook,” shall be conducted for each pressure system within the scope of the recertification program or as directed by the LaRC Safety Manager.

2.4.5.2 Risk Analyses shall identify all credible hazards associated with the operation of a system and characterize those hazards in terms of their severity and probability of occurrence.

2.45.3 Throughout the life of a pressure system, new risks shall be identified, as needed, as a result of in-service inspections and recertification actions.

2.4.6 Recertification Letters

2.4.6.1 When all components and welds in the system satisfy the requirements, the RGM shall notify the PSM to send a Recertification Letter to the FSH and the FC. See Figure E-4 for a sample Recertification Letter.

2.4.6.2 Recertification letters shall be maintained in the Recertification file.

CHAPTER 3

3.0 REQUIREMENTS FOR THE MAINTENANCE OF PRESSURE SYSTEMS

3.1 General

3.1.1 This chapter outlines the elements of the LaRC Maintenance Program that work together with the Recertification Program to effectively maintain pressure system integrity.

3.2 Preventive Maintenance (PM) Program

3.2.1 The PM program consists of a time-based schedule of maintenance activities that are executed at an established frequency.

3.2.2 Pressure relief valves and burst disks are the primary safety devices in pressurized systems. These devices are intended for protection from overpressure caused by:

a. the failure of pressure regulators and other pressure control valves
b. runaway conditions of compressors and blowers
c. external or internal heat sources
d. evaporation of trapped cryogenic liquids

3.2.3 Appendix D provides the required frequencies for the verification of relief valve set points. Burst disks are not required to undergo PM.

3.2.4 Bourdon-tube pressure gages shall be retested in accordance with LPR 1710.40, “Langley Research Center Pressure Systems Handbook.”

3.2.5 The ROME Contractor is responsible for ensuring periodic testing of safety relief valves and bourdon-tube pressure gages is conducted in accordance with the schedule in the Computerized Maintenance Management System (CMMS), tagging them after testing, and returning them to service.

3.3 Component Verification Facility

3.3.1 The Component Verification Facility is a key element of the pressure system maintenance program. In this facility, the following services are performed:

a. hydrostatic testing (pressures up to 50,000 psig)
b. pneumatic testing (potential energy up to 8,500 foot-pounds)
c. relief valve set point verification

d. relief valve rebuilding using Original Equipment Manufacturer (OEM) parts and procedures
e. pressure gage verification

3.3.2 The Component Verification Facility shall maintain a log identifying each relief valve, pressure gage, or other piece of equipment tested, the date of the test, and the results of the test.

APPENDIX A - DEFINITIONS

A.1 **Dewar:** A glass bottle or metal vessel, with a double-wall construction used to contain cryogenic liquids at temperatures below −240 °F. The annular space between the inner vessel and the outer jacket is evacuated almost entirely of air, thus minimizing heat conduction and convection.

A-2 **K-bottle:** A cylindrical container for compressed gases. K-bottles are commonly designed to hold a volume of 1.5 cubic feet of water and are built to specifications governed by the United States Department of Transportation (DOT). Common pressure ratings for k-bottles are: 3K – 3600 psig, 4K – 4500 psig, 6K – 6000 psig.

A-3 **National Consensus Codes and Standards**: A document which (1) has been adopted or distributed by a nationally recognized standards producing organization under procedures whereby it can be determined by the Secretary of Labor or by the Assistant Secretary of Labor for Occupational Safety and Health that persons interested and affected by the standard have reached substantial agreement on its adoption; (2) was formulated in a manner that afforded an opportunity for diverse view to be considered; and (3) has been so designated by the Secretary or the Assistant Secretary, after consultation with other appropriate Federal Agencies.

APPENDIX B – ACRONYMS

ASME	American Society of Mechanical Engineers
ASNT	American Society of Nondestructive Testing
B&PV	Boiler and Pressure Vessel
CCD	Configuration Controlled Document
CMMS	Computerized Maintenance Management System
CMOL	Configuration Management On-Line
DOT	Department of Transportation
EDF	Electronic Drawing File
FC	Facility Coordinator
FSH	Facility Safety Head
IP	Inspection Plan
LF	Langley Form
LPR	Langley Procedural Requirements
LaRC	Langley Research Center
MAWP	Maximum Allowable Working Pressure
MT	Magnetic Particle Examination
NBBI	National Board of Boiler Inspectors
NDE	Nondestructive Examination
OEM	Original Equipment Manufacturer
ORR	Operational Readiness Review
PD	Process Diagram
PID	Process and Instrumentation Diagram
PM	Preventive Maintenance
PSD	Pressure Systems Document
PSIG	Pounds Per Square Inch Gauge
PSM	Pressure Systems Manager
PVS	Pressurized Vessels and Pressurized Systems
RGM	Recertification Group Manager
RT	Radiographic Examination
SAR	Safety Analysis Report
SFAB	Safety and Facility Assurance Branch
SOC	Systems Operations Committee
SPE	Standard Practice Engineer
UT	Ultrasonic Examination
UTT	Ultrasonic Thickness Examination
VT	Visual Examination

Note: The acronyms UT, UTT, MT, RT, VT are old acronyms and were redefined by the National Board using the word examination; however, the old acronyms are still being used.

APPENDIX C - RECOMMENDED PRACTICES FOR THE DEVELOPMENT OF PRESSURE SYSTEMS INSPECTION PLANS (IP)

C.1 General

a. This Appendix serves as a guide for the development of IP's for pressure systems. These plans list the inspections necessary to monitor the condition of a pressure system on a time-based schedule or a run cycle-based schedule. Secondary goals include, but are not limited to, the field verification of system documentation and the verification of the certification status of relief devices and pressure gages.

C.2 Inspection Plans (IP)

As a minimum, an IP should contain the following information:

a. *Inspection Technique*: The IP should list the inspection techniques that are required for a specific inspection task.

b. *Inspection Intervals*: If the inspection plan is time based, the IP should present a schedule at least as long as the system's recertification interval. If the inspection plan is based on cycles of operation, the IP shall present the maximum number of run cycles between inspections, the current year cycle count, and the maximum number of cycles between system recertification. It is the responsibility of the owner of the pressure system to maintain a log of the pressure and thermal cycles incurred by a cycle-limited pressure system.

c. *Inspection Procedure and Acceptance Criteria*: The IP should list the applicable procedure to be followed in performing each inspection point, e.g., LMS-TD-5569 for visual inspections, or ASME Section V and Section VIII for other inspection techniques.

Notes: The IP shall identify any special conditions, special requirements, or waivers that may affect the inspection process.

Notes: See Figure E-5 for a sample inspection plan.

d. Not all pressure systems are necessarily affected by the same degradation mechanisms. The inclusion of inspection tasks in an IP shall be based on the expected mode of degradation and the suitability of the selected NDE techniques to detect the degradation. See Table C.2-1.

e. Inspection intervals selected shall give consideration to the specific degradation mechanisms affecting the item being inspected. Table C.2-2 provides guidelines for minimum required in-service inspection for systems affected by internal or external corrosion.

f. When basing in-service inspection intervals on analysis techniques such as fatigue analysis or fracture mechanics analysis, the maximum inspection intervals for that system or component shall be equal to ½ the calculated remaining life or 20 years, whichever is less.

Inspection intervals for relief valves and pressure gages shall be based on their required retesting frequency. See Appendix D.

C.3 Changes to inspection intervals

a. When the results of at least three consecutive in-service inspections performed at the intervals specified in an IP show that no degradation is detected, the RGM may extend the inspection intervals with concurrence from the PSM.

b. When the results of two consecutive in-service inspections in a specific area of a pressure system show signs of degradation even after corrective actions were performed, the RGM shall shorten the inspection interval for the area of interest and notify the FSH and the PSM.

Table C.2-1 – Applicability of NDE Techniques for Recertification of Systems

NDE Technique	Recommended for	Not Recommended for
Visual (VT)	Detecting surface defects (e.g., surface cracks, corrosion, weld undercut)	Detecting subsurface defects
X-ray (RT)	Detecting internal fabrication defects such as inclusions, voids, incomplete fusion, incomplete penetration, porosity, and improper joint fit-up	Finding service-induced flaws such as cracks
Ultrasonic (UT)	Detecting internal fabrication defects such as inclusions, voids, incomplete fusion, and incomplete penetration. Characterizing size and location of sub-surface cracks and plate laminations. Determining wall thickness	Examination of complex geometries
Eddy Current (ET)	Detecting surface or shallow defects on smooth surfaces	Detecting deep subsurface defects
Acoustic Emission (AE)	Detecting and locating cracks propagating inside a pressure vessel wall under stress	Detecting defects in systems that are depressurized
Dye penetrant (PT)	Detecting surface cracks and other defects open to the surface on clean, paint-free surfaces (e.g., surface porosity and weld undercut)	Detecting subsurface defects
Magnetic particle (MT)	Detecting surface cracks, linear surface defects, and weld undercut.	Examination of non-magnetic materials, examination of joints made of materials with different magnetic permeability, or detecting subsurface defects

Table C.2-2 – Some Recommended Inspection Intervals

Degradation Mechanism	Location of System	Recommended Inspection
External Corrosion	Underground utility tunnels	VT and UTT every 2 yrs
External Corrosion	Outdoors	VT and UTT every 4 yrs
External Corrosion	Indoors (climate controlled)	VT and UTT every 8 yrs
Internal Corrosion	All	VT (borescope) every 2 yrs

APPENDIX D – REQUIRED RELIEF VALVE SET POINT VERIFICATION INTERVALS

Systems Containing Water

Water piping systems	P ≤ 160 psig and T ≤ 210 °F and not subject to water surge	Excluded
Water piping systems	Not excluded above	5 years
Water heaters (COTS)	All	5 years
Hot water heating boilers for facilities (COTS)	All	5 years
Water deluge systems	P ≤ 250 psig	Excluded
Water deluge systems	Not excluded above	5 years
Water storage tanks	Not pressurized	Excluded
Water storage tanks	Pressurized	5 years
Fire protection systems for facilities (water)	All	Excluded
COTS pressurized cleaning systems (water)	All	Excluded
COTS, self-contained, pressurized eye wash systems	All	Excluded

Systems Containing Steam and Condensate

Steam heating boilers for facilities (COTS)	P ≤ 15 psig and H-stamped	Excluded
Steam heating boilers for facilities (COTS)	Not excluded above	1 year
Central heating boilers in Building 1215	All	Per Virginia DOLI Regs
125 psig and 350 psig steam piping	All	1 year
Steam and condensate piping for building heat	P ≤ 15 psig	Excluded (*)
Steam and condensate piping for building heat	Not excluded above	1 year
COTS pressurized cleaning systems (steam)	All	Excluded

(*) Steam relief valves set @ 15 psi or less are excluded with the exception of the first relief valve downstream of a 125 psi or 350 psi regulator.

Systems Containing Inert Gases (e.g., dry air, nitrogen, argon, helium)

Inert gas piping systems	P ≤ 150 psig and Diameter ≤ 1 ½"	Excluded
Inert gas piping systems	Not excluded above	3 years
Pressure vessels (incl. pressurized tunnel shells)	All	3 years

Systems Containing Cryogenic Liquids of Nitrogen, Argon, Helium, and Oxygen

Cryogenic piping systems	All	5 years
Pressure vessels	All	5 years
Storage tanks (dewars)	All	5 years

Systems Containing Vacuum

Vacuum piping	Nominal diameter < 6 inch	Excluded
Vacuum piping	Nominal diameter ≥ 6 inch	5 years
Vacuum vessels with no positive pressure source	All	Excluded
Vacuum vessels with positive pressure source	RV set point ≥ 2 psig	5 years
Vacuum vessels with positive pressure source	RV set point < 2 psig	10 years

Systems Containing Flammables (e.g., LP, methane, H_2, ethylene, silane, JP7, fuel oil)

Natural gas distribution piping	Owned by VNG	Excluded
Natural gas piping in facilities	Owned by NASA	2 years
Fuel storage tanks (liquid)	All	10 years (**)
Pressure vessels	All	2 years
Piping systems	All	2 years
Fuel systems in motorized vehicles (DOT certified)	All	Excluded

(**) Internal relief valves in fuel tanks shall be replaced every 10 years

Other Systems

HVAC Systems, refrigerators, and freezers (COTS)	All	Excluded
Prepackaged hydraulic systems (COTS)	All	Excluded
Welding equipment (COTS)	All	Excluded
Glove boxes (COTS)	All	Excluded
RV protecting laboratory equipment	Inert gas supplied by K-bottle and regulator	5 year
RV protecting laboratory equipment	Corrosive, flammable, or toxic gas supplied by K-bottle and regulator	2 year

APPENDIX E – Figures

Figure E-1, Sample of a Typical Organization of a Recertification File

A. Title Sheet
    1. System Name
    2. System Location
    3. System Serial Number

B. Revision Sheet

C. System Description
    1. Abstract
    2. Pressure System Document number
    3. Safety Analysis Report number
    4. Drawing numbers

D. Integrity Assessment
    1. ASME U-1A Reports (Div. 1)
    2. ASME A-1 Reports (Div. 2)
    3. Materials of Construction
        a. Special Welding Procedures
        b. Mill Reports / Chemical Analyses
        c. Material Properties
        d. Hardness Measurements
        e. Heat Treatment Records
        f. Fatigue Test Reports
        g. Fracture Toughness / Fatigue Test Reports
    4. Engineering Analyses
        a. Code/Sizing Calculations
        b. Flexibility Analysis
        c. Relief Device Sizing
        d. Other
    5. High Stress Areas Identification
    6. Hydrostatic / Pneumatic Test Reports

E. Initial Service Life
    1. Corrosion Degradation
        a. Minimum Required Thicknesses
        b. Initial Thickness Measurement Data
    2. Fracture Degradation
        a. Fatigue/Fracture Analysis

APPENDIX E – Figures (continued)

F. Remaining Life
    1. Corrosion Degradation
        a. NDE Reports (VT)
        b. Thickness Measurements (UTT)
        c. Condition Assessments
    2. Fracture Degradation
        a. NDE Reports (UT, RT, ET, PT, MT, VT)
        b. Actual Cycle Counts
        c. Estimated Cycle Counts

G. In-service Inspections
    1. Inspection Plan
        a. Latest Version
    2. Inspection Plan Rationale
    3. Inspection Results
        a. Historical Records

H. Risk Assessment
    1. SAR Attachment

I. Miscellaneous Records
    1. Manufacturer's Catalog Cuts
    2. Purchase Requisitions
    3. Photographs
    4. Unresolved Inspection Findings
    5. Pressure Systems Committee / Executive Safety Council Waivers
    6. SPE / PSM Interpretations
    7. Recertification Letter
    8. Other Documents

Figure E-2, Sample Sketch in a Pressure System Document

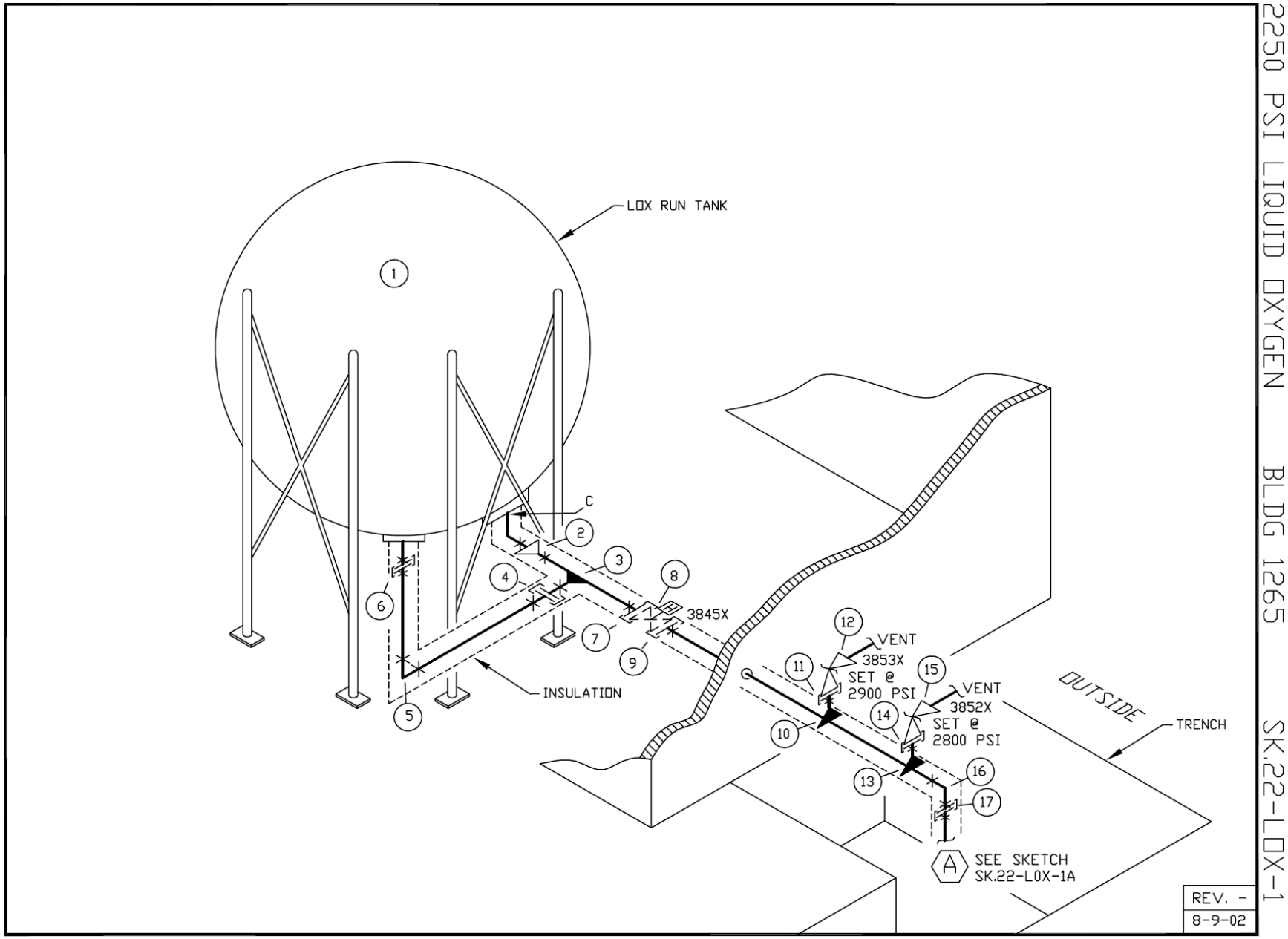

Figure E-3, Sample Component Database Sheet in a Pressure System Document

CONFIGURATION CONTROLLED DOCUMENT

03-2250LOX-PSCM

FACILITY: BLDG. 1265

SYSTEM: 2250 PSI LIQUID OXYGEN

REFERENCE SKETCH: 22-LO-1

RECERTIFICATION STATUS SHEET

JAN 29, 2003

NO	Component	END	Manufacturer / Description	Material	Installation	Inspection	Rated Pressure	Working Pressure	Code	Analysis	NDE	Foot Notes	Reference	Rec
1	LOX RUN TANK	BW	SOUTHEAST WELDING AND MFG 14", S/N 20023/20024 8000 GALLON, "U" STAMP	STAINLESS	12/89	02/98	2290	2250	81	ES	V		D1, D2, D3	RC
2	PIPE REDUCER	BW	GULF ALLOY INC. 14" X 6", SCH 120	A403 GR 304	12/89	02/98	2892	2250	B9	PS, CE	V	4	A1, D1, D2, D3, D4	RC
3	WELDOLET	BW	GULF ALLOY INC. 4", SCH XXS	A182 GR 304	12/89	02/98	5859	2250	B9	PS, CE	V	4	D1, D2, D3, D4	RC
4	FLANGE ASSEMBLY	BW	R-CON INC 4", SCH XXS	A182 GR 304	12/89	02/98	7013	2250	B3	MC	V		D1, D2, D3, D4	RC
5	PIPE ELL	BW	GULF ALLOY INC. 4", SCH XXS	A403 GR 304	12/89	02/98	5859	2250	B9	PS, CE	V	4	D1, D2, D3, D5	RC
6	FLANGE ASSEMBLY	BW	R-CON INC 4", SCH 160	A182 GR 304	12/89	02/98	4114	2250	B3	MC	V	17	D1, D2, D3, D5	RC
7	FLANGE ASSEMBLY	BW	R-CON INC 6", SCH XXS	A182 GR 304	12/89	02/98	4899	2250	B3	MC	V		D1, D2, D3, D4	RC
8	CONTROL VALVE 3845X	FL	MASONEILAN 6", M/N 467 2500#	STAINLESS	12/89	02/98	6000	2250	B4	TC	V	15	D1, D2, D3, D4, D8	RC
9	FLANGE ASSEMBLY	BW	R-CON INC 6", SCH XXS	A182 GR 304	12/89	02/98	4899	2250	B3	MC	V		D1, D2, D3, D4	RC
10	WELDOLET	BW	GULF ALLOY INC. 1 1/2", SCH XXS	A182 GR 304	12/89	02/98	6941	2250	B9	PS, CE	V	4	D1, D2, D3, D4	RC
11	FLANGE ASSEMBLY	BW	R-CON INC 1 1/2", SCH XXS	A182 GR 304	12/89	02/98	6919	2250	B3	MC	V		D1, D2, D3, D4	RC
12	RELIEF VALVE 3853X	BW	ANDERSON & GREENWOOD 1 1/2",M/N 81S1216-8 SET @ 2900 PSI	STEEL	12/89	02/98	2900	2250	N/A	MC, TC	V	9	D1, D2, D3, D6, D8	RC

13

SHEET: 1 of 3

CONFIGURATION CONTROLLED DOCUMENT

REV. A

Description of the Recertification Status Sheet Columns in Figure E-3:

Fifteen Columns - Read Left to Right

(1) **NO**: Component number which can be found on the sketch referenced in the upper right of the recertification status sheet. (Example: REF SK. 60-A-1)

(2) **COMPONENT**: Component name.

(3) **END**: End connection type. It is listed by abbreviation: TH = threaded; SW = socket weld; BW = butt weld; FL = flanged; CW = connection weld; SO = slip on; WN = weld neck (for flanges only).

(4) **MANUFACTURER/DESCRIPTION**: Manufacturer's label information gathered in the field. The first line gives the manufacturer name (if known). The second line lists the line size of the component and model number, serial number, class, or type. The last line contains any additional information available.

(5) **MATERIAL**: Material the component is made of or is assumed to be made of.

(6) **INSTALLATION**: Component's installation date.

(7) **INSPECTION**: In-service inspection date.

(8) **RATED PRESSURE**: Maximum allowable working pressure of the component. This number is arrived at by: information found on the component; information found in the manufacturer's catalog; comparing the components dimensions to dimensions given in the applicable code or standard; by making contact with the manufacturer by phone or by letter; or by using the pipe pressure formula from ASME B31.

(9) **WORKING PRESSURE**: Working pressure (WPRES) of the system at the component's location.

(10) **CODE**: Code or standard that the component meets. The codes are abbreviated. The abbreviations are explained on the Definition of Symbols page. Entries in the CODE column come from the Manufacturer's catalogs, crossing the component's dimensions with dimensions listed in the code, or by contacting the manufacturer.

(11) **ANALYSIS**: Method of analyzing or evaluating the component. Abbreviations are explained on the Definition of Symbols page.

(12) **NDE**: Method of non-destructive examination used to evaluate the component. Abbreviations are explained on the Definition of Symbols page.

(13) **FOOTNOTES**: Footnotes which further explain or clarify the information for the component. Footnotes are specific to a system and can be found on the Footnotes page located in the back of the PSD.

(14) **REFERENCE**: NASA specifications, NASA drawings, Engineering Analysis, and Non-Destructive Examination. These can be referenced on the Document Reference List page located in the back of the PSD.

(15) **REC**: Recommendation for each component. The component is either recertified or recommended for removal (RM), repair (RP), or derating (DR). A letter (W) in this field indicates that a waiver has been issued for this component.

Figure E-4, Sample Recertification Letter

National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia
23681-0001

M/S 241

August 27, 2009

TO: 267/Facility Safety Head, Building 1236

FROM: 241/Pressure Systems Manager, Standard Practices Office, Facilities Engineering and Maintenance, COD

SUBJECT: Recertification of the 1800 Psi Air System (18-A4)

REF:
1. NASA STD 8719.17, "NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems"
2. LPR 1710.42, "Safety Program for the Maintenance of Ground-Based Pressure Vessels and Pressurized Systems"
3. LPR 1710.40, "LaRC Pressure Systems Handbook"

The purpose of this letter is to document the completion of the recertification of the subject system. This system starts at the pressure reducing station in Buildings 1146D and 1146F and terminates in the basement of Building 1236 at valve 059-3041A. All required engineering analyses, nondestructive examinations (NDE), and corrective actions, if any, have been completed and accepted. All components in the system satisfy the requirements of the referenced NASA and Langley Research Center standards and requirements.

An inservice inspection plan for this system has been developed and placed in the Configuration Management Online (CMOL) system at http://cmol.larc.nasa.gov. The inspection plan lists the nondestructive examinations that are required for this system to maintain its operational certification status.

Additionally, a Pressure Systems Document (PSD) has been developed which includes isometric sketches and listings of all the high-energy pressure retaining components in the system. This document has been placed under configuration control in CMOL. Any changes to the configuration of the system shown in the PSD will require a Change Notification Sheet (CNS) to be generated and routed for approval.

If you have any questions regarding this letter, do not hesitate to contact me.

Pressure Systems Manager
864-7258

Concur:

ROME Recert Lead
864-5163

Cc:
302/C. A. Swarts

Figure E-5, Sample Inspection Plan

INSPECTION PLAN FOR THE COMBUSTOR PRESSURE SHELL AND END CLOSURE AT BLDG 1265
RESULTS OF ALL INSPECTIONS SHALL BE REPORTED TO THE LaRC PRESSURE SYSTEMS MANAGER AND THE FACILITY SAFETY HEAD

ITEM NUMBER	DWG/SK NUMBER(S)	COMPONENT LOCATION	WELD / COMPONENT	INSPECTION SCHEDULE												INSPECTION REQUIREMENTS
				2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
1	704167	5--1	GASKET RETAINING RING				VT						VT			LMS-TD-5569
2	704165	3--1	INTAKE CLOSURE COVER				VT						VT			LMS-TD-5569
3	1081402	DET-J	COMBUSTOR RETAINING RING		MT						MT					PROCEDURE: ASME B & PV CODE, SECTION V ACCEPTANCE CRITERIA: SECTION 8, DIV. 1
4	-	INSIDE & OUT	COMBUSTOR SHELL WELDS				MT									PROCEDURE: ASME B & PV CODE, SECTION V ACCEPTANCE CRITERIA: SECTION 8, DIV. 1
5	704153	DET B & E	LAMINATED SECTION WELDS						MT							PROCEDURE: ASME B & PV CODE, SECTION V ACCEPTANCE CRITERIA: SECTION 8, DIV. 1
6	704165	3-2 3-3 3-6 3-7, 3-8, 3-9	FUEL PIPING	MT		MT		MT		MT		MT		MT		PROCEDURE: ASME B & PV CODE, SECTION V ACCEPTANCE CRITERIA: SECTION 8, DIV 1
7	704165	3--13	FUEL CHECK VALVE		VT						VT					LMS-TD-5569
8	550412		FUEL BURNER		PT						PT					PROCEDURE: ASME B & PV CODE, SECTION V ACCEPTANCE CRITERIA: SECTION 8, DIV. 1
9	550412		ALL WELDS		PT						PT					PROCEDURE: ASME B & PV CODE, SECTION V ACCEPTANCE CRITERIA: SECTION 8, DIV. 1
11	704172	10-1 10-2	COMBUSTION AIR MANIFOLD		MT						MT					PROCEDURE: ASME B & PV CODE, SECTION V ACCEPTANCE CRITERIA: SECTION 8, DIV. 1
13	1081458	SECTION BB, CC, DD	DOWNSTREAM SHELL SHT 4 MIXER				MT									PROCEDURE: ASME B & PV CODE, SECTION V ACCEPTANCE CRITERIA: SECTION 8, DIV. 1
14	500796	ALL	MACH 7 NOZZLE EXTERIOR WELDS	VT		VT		VT		VT		VT		VT		LMS-TD-5569
15	1081555 SHEET 3 & 4	ITEMS 2 & 3	NOZZLE HOUSING WELDS				PT									PROCEDURE: ASME B & PV CODE, SECTION V ACCEPTANCE CRITERIA: SECTION 8, DIV. 1
16	1081556 SHEET 2	ITEMS 2 3.5 6	SPOOL HOUSING WELDS				PT									PROCEDURE: ASME B & PV CODE, SECTION V ACCEPTANCE CRITERIA: SECTION 8, DIV. 1
17	500796	ALL	MACH 7 NOZZLE EXTERIOR WELDS				PT									PROCEDURE: ASME B & PV CODE, SECTION V ACCEPTANCE CRITERIA: SECTION 8, DIV. 1
18	704165	3-4 3-5	FUEL PIPING	VT		VT		VT		VT		VT		VT		LMS-TD-5569

NOTE: FACILITY SAFETY HEAD SHALL NOTIFY THE LARC PRESSURE SYSTEMS MANAGER WHENEVER THE LINER IS REMOVED AND INSPECTIONS OF ITEMS 4 AND 5 SHALL BE PERFORMED

FACILITY BASELINE DRAWING
FIELD VERIFIED BY:
APPROVED BY

CONFIGURATION CONTROLLED
DOCUMENT EC 03

REFERENCE DOCUMENT: N/A

DATE	LTR	FREQ	DESCRIPTION	BY	CHK	APPD
2/12/2008	H	_	CNS 03-639: CHANGED PT TO MT ON ITEM 6, ADDED ITEM 18, UPDATED INSPECTION SCHEDULE. REV. FLD. VER.			
08/10/04	G	_	CNS 03-575: MOVED PT PORTION OF ITEM 14 TO ITEM 17.REVISE INSP INTERVALS BASED ON INSP HISTORY REV FLD. VER	JC	RMK	RJW
01/17/03	F	_	CNS 03-529: DEL. ITEM # 12. INACCESSIBLE. REV. FIELD VER.	BAG	RMK	RJW
12/03/02	E	_	CNS 03-526 DELETED ITEM 10. UPDATED DRAWING NO.S CHANGED DRAWING SIZE. REV. FLD. VER.	BAG	RMK	RJW

REVISIONS

ROME
Research Operations, Maintenance, and Engineering
3A EAST AMES ST., BLDG 1189
HAMPTON VA 23681

NNL04AA03B

APPROVALS	DATE
DRAWN C. PRICE	1/8/98
CHECKED D. GIANETTINO	1/13/98
NASA REP C. M. HUDSON	1/13/98

NATIONAL AERONAUTICS & SPACE ADMINISTRATION LANGLEY RESEARCH CENTER
HAMPTON, VIRGINIA 23665-5225

TITLE: 8 FOOT HIGH TEMPERATURE TUNNEL COMBUSTOR SHELL, BUILDING 1265 INSPECTION PLAN

SIZE	FSCM NO.	DWG NO.	REV
A		740523	H

SCALE	BLDG	SHEET
NONE	1265	1 OF 1